

for safety; and, lastly, as to the financial return and the disposal of profits when such exist.

The second portion of the book is more directly concerned with light railway development in England. A useful chapter is concerned with an analysis of the Act of 1896, while the special chapters on "The Question of Gauge" and on "The Construction and Working of Light Railways" are perhaps the most valuable in the book. On the question of gauge it may be worth while to quote Mr. Cole's conclusion, which is that for railways making connection with main lines the standard gauge is imperative, and that for smaller independent lines the reduced gauge of thirty inches may be used. In this connection we notice no reference to the Duke of Westminster's narrow-gauge railway at Eaton Hall, though this is, perhaps, the most instructive example of a small and self-contained railway in the United Kingdom.

The book contains a number of folding plates, showing details of construction both of permanent way and of rolling stock; and a long appendix includes tables of returns for many railways, both of standard and of light construction, as well as the full text of the Act of 1896 and its schedules.

Les Plaques sensibles au Champ électrostatique. Par V. Schaffers, S.J. Pp. xxxix + 19. (Paris: A. Hermann, Librairie Scientifique, 1900.)

THE phenomena treated of in this pamphlet are those observed when an electric discharge from a powerful Whimshurst was passed over the film of a photographic plate between two metallic points which usually were both in contact with the film. A great variety of films, containing various metallic salts mixed with different emulsions, &c., besides those ordinarily used for photographic purposes, were tried.

The potential difference used was not enough to spark across between the poles, and the changes produced in the films are probably mainly due to the current through the film, and not to the discharges through the air above it. In some cases the marks produced on the plate were approximately parallel to the lines of electrostatic force or current stream lines through the film, and several plates are given showing the effects obtained in such cases. A considerable variety of peculiar and more or less interesting appearances are clearly described, and possible explanations of them discussed. Scarcely any variations in the method of submitting the material to the action of the discharge were tried, and the object of the experimenter seems to have been more to obtain a large variety of peculiar appearances than to really elucidate the nature of the actions taking place. The method of obtaining pictures of the lines of force or current stream lines between conductors on the plates is described in detail, and such pictures as the author points out may be useful for educational purposes in some cases.

H. A. W.

The Elements of Plane Trigonometry. By Prof. W. P. Durfee. Pp. vi + 105. (Boston, U.S.A.: Ginn & Co., 1900.)

THERE are a few novel points in this book. Logarithms and their use in computations are dealt with in the first chapter, and most of the exercises are of a character which will lead the student to see that trigonometry has a practical value. The second chapter deals with trigonometrical ratios, and is followed by chapters on unlimited angles, reduction formulæ, the addition theorem, relations between the sides of a triangle and the trigonometrical functions of its angles, and solution of triangles. Logarithms are used in all the calculations. The course of work in the book is suitable for elementary studies of trigonometry, and constitutes an introduction to the theory of functions as illustrated by trigonometrical ratios.

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LETTERS TO THE EDITOR.

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Autotomic Curves.

MR. RICHMOND'S letter appears to be written under a misapprehension. My objection to such phrases as "non-singular cubic curve," "non-singular curve of the n th order," arises from the fact that a point of inflexion is just as much a singularity as a node, and that it is therefore inaccurate and misleading to describe such curves as non-singular. In fact, the only non-singular curves which exist are conic sections; all others are singular. On the other hand, the word autotomic exactly expresses the idea it is desired to convey; and I have been informed by several excellent Greek scholars that they do not consider the phrase "an anautotomic curve" open to objection, and that the alliteration may be frequently avoided by the use of the words every or any instead of an.

The terms *sesecting* and *non-sesecting* appear to be unobjectionable from a literary point of view; but with regard to *un-autotomic* and *nodeless* there is a general consensus of opinion amongst writers who are careful about their style against the use of hybrid terms composed of words belonging to two different languages.

A. B. BASSET.

Fledborough Hall, Ilolyport, Berks, November 16.

A Remarkable Dolphin.

DR. WAY, the headmaster of Rossall School, has recently forwarded to the Natural History Museum (for determination) portions of a cetacean stranded at Rossall in September. These portions include the skull, the imperfect flippers, the tail (including the caudal vertebrae), and the back-fin.

The skull and other bones leave no doubt that the animal is the bottle-nosed dolphin (*Tursiops tursio*). In place, however, of the ordinary "flukes" of a dolphin, the tail terminates in two long, narrow lobes, of which one is very much longer than the other; and, were it not placed in a horizontal instead of a vertical plane, it might well be mistaken for the tail of a thresher shark. The larger lobe of the tail measures 5 feet 3 inches, while the total length of the remainder of the creature was 10 feet. A similar abnormal elongation is noticeable in the case of the back-fin, which is about twice as long as ordinary, and proportionately slender. Externally, both the tail and the back-fin are thickly coated with small sea-weeds and sertularians.

Judging from the teeth, the animal appears to be very aged, and the only conjecture I can make in regard to the tail and back-fin is that their abnormal form is due to pathological hypertrophy, perhaps induced by an injury. I should be glad to hear of any other instances of analogous malformation among cetaceans.

R. LYDEKKER.

British Museum (Natural History), Nov. 19.

The Optics of Acuteness of Sight.

OBSERVATIONS have been frequently made upon the remarkable eyesight of certain uncivilised tribes. Travellers have told us of guides who could see four of Jupiter's satellites with the unaided eye; and lately Sir Redvers Buller has declared that the average Boer can see at least two miles further than the British soldier. It is of some interest to consider whether this superiority is due to a real change in the optical properties of the eye, or merely to some special ability to interpret slight differences of impression, which might be acquired by practice. As we have as yet no data as to the constants of a Boer's eye, we may raise the question whether such feats are optically impossible for an Englishman's eye.

The minimum visual angle is determined by the transverse diameter (c) of a foveal retinal cone, and its distance ($F'K''$) from the second nodal point of the eye. We have—

$$\tan \frac{\alpha}{2} = \frac{\frac{1}{2}c}{F'K''}$$

and, where $c = .002$ mm., $F'K'' = 15.498$ mm.

$$\alpha = 26.618''$$

In order that two points may be distinguished as such by the

eye, their retinal images must be separated by at least one unexcited retinal cone. The distance between the two images must therefore be .004 mm., or the intervening cone may be encroached upon. Therefore the minimum visual angle

$$\theta = 2\alpha = 53'236''.$$

Now Jupiter's edge and his first satellite may subtend at the sun an angle of $1'33''$, so that we may regard this as the average angle subtended at the earth. Hence we see that there is no optical reason why the four satellites should not be seen by the naked eye. If they were sufficiently bright they no doubt could be distinguished by the normal Englishman's eye. "It must be remembered, however," as Sir Michael Foster says, "that the fusion or distinction of sensations is ultimately determined by the brain. The retinal area must be carefully distinguished from the sensational unit, for the sensation is a process whose arena stretches from the retina to certain parts of the brain, and the circumscription of the sensational unit, though it must begin as a retinal area, must also be continued as a cerebral area, the latter corresponding to, and being, as it were, the projection of the former." No amount of education can make the sensational unit smaller than the minimum retinal area, though by practice the cerebral area may be made more sensitive to minute sensational impulses.

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ELECTRIC TRACTION TROUBLES.

THE English—the pioneers in the development of railways, steamships, the telegraph, and other inventions of the nineteenth century—are now running the risk of becoming a nation of imitators. Apart from the fact that the entire route, Shepherd's Bush to the Bank, was not sent bodily across the Atlantic to be tunnelled, the Central London Railway might almost as well have been constructed in Central America as in Central London.

For not merely did the steam-engines come from Milwaukee, the electric lifts from New York, the dynamos, locomotives, and other electric apparatus from Schenectady, but the curious practice of requiring a passenger to first purchase a ticket and then drop it immediately into a box, as well as the projection of information into each end of a car on quitting each station are Yankee notions, and one expects to hear that the "next station is Chippawa" or Winnetka, and not commonplace Bond Street or Oxford Circus.

The characteristics of American traction are convenience, comfort, speed, low fares and a liberal scattering of the electric current over the district generally. Chinese like, we have faithfully adopted them all. To go from the City to the Albert Hall, up to this summer, one went, of course, from the Mansion House to the South Kensington railway stations. Now one saves time and money by being whisked electrically to Lancaster Gate and walking across Kensington Gardens. No wonder, then, on C.I.V. Monday 230,000 people used the Central London Railway, enough passengers, in fact, to fill every seat one and a quarter times in every train from early morn on Monday to the small hours of the following day.

No need to issue return tickets at reduced rates when every passenger who goes by this line can be relied upon to return by it. What matters it, then—may think the artisan, the clerk, the stockbroker, the investor, and even, perhaps, the engineers and directors of the Central London Railway itself—by what route the electric current returns? The electric current that starts from the Marble Arch, say, must, from the nature of things, go back there. Why, then, should advantages be offered it that are not thought necessary in the case of the general public to induce a return home inside the tube?

If one were a shareholder *only* of the Central London Railway, one might find it difficult to realise that any

other interest was of any consequence. But, if a considerable portion of one's income happens to be derived from dividends on the shares in gas and water companies, one may prefer that these sources of income shall not be seriously interfered with. Hence, the clean white glazed brick walls, the brilliant arc lamps, the pleasant gliding lifts, the entire absence of those rolling clouds of smoky steam that greet a passenger as he descends into the Euston Road on a damp, cold November day, fail to cheer him on his swift modern progress under Oxford Street, should he make the following little elementary calculations:—Over 2000 electric horse-power which, at times, every day is already actually put into the Central London Railway at a single sub-station between Shepherd's Bush and the Bank means a current of over 3000 amperes; and this current, after passing through the electro-motors on the trains in the neighbourhood of that sub-station, has to come back there through the *uninsulated* rails on which the trains run. Suppose, in consequence of these rails being *uninsulated*, 10 per cent. of this return current strays outside the iron tube and comes back by the iron gas and water pipes running parallel with the railway on the ground above it. This means about $\frac{1}{10}$ lb. of iron removed from the gas and water pipes in an hour in the neighbourhood of a sub-station.

Such large currents, however, as 3000 amperes are at present probably only seldom reached, therefore, to avoid even an approach to exaggeration, let us assume that the average current which strays into the gas and water pipes on its way back to a sub-station is only, say, $\frac{1}{100}$ th of the maximum value of the current leaving a sub-station each day. This seems a modest enough estimate. Then, since the line works some eighteen or more hours per day, this means about *a quarter of a ton of iron* removed per year from the gas and water pipes in the neighbourhood of *each* of the places at which the current is fed into the railway. Consequently, as there are several such places between Shepherd's Bush and the Bank, this would lead to more than *one ton of iron* being eaten out of the pipes each year.

Is this important? Well, as holders of gas and water companies shares we should say, very! But are the travelling facilities of the London public to be interfered with, is the development of electric traction to be hampered—just when our people are having their first taste of the immense advantages that accrue from propelling trains and tramcars by electricity—simply because several millions sterling happen to have been invested on pipes, retorts, gasometers, waterworks, &c., and because there are people so blind as to actually prefer the receipts of regular dividends to the slavish copy of American practice?

Luckily, no such terrible alternative need be flourished in the faces of our democratic governing bodies, who, while naturally anxious to defend the people from the supposed extortions of the gas and water companies, are no less anxious to shield from the incursions of the electric traction capitalist a large class of persons with small incomes who have placed their savings in what they rightly regarded as safe investments—viz., the shares of gas companies.

Another electric service has been inaugurated this year in which trains as large as, or larger than, those on the Central London Railway are driven electrically over a far more difficult route—viz., from Earl's Court to High Street, Kensington, among ordinary trains over points and crossings.

And yet, in spite of this greater difficulty, there is not merely an insulated conductor to take the electric current to the trains, as on the Central London Railway, but also an insulated conductor to bring it back by; and the rails on which the electric trains run between Earl's Court and High Street, Kensington, are used simply for